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Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

Lubrication of Rock Products Machinery

PUBLISHED MONTHLY BY
THE TEXAS COMPANY, U.S.A.
TEXACO PETROLEUM PRODUCTS

TEXACO LUBRICANTS

For Rock Products Machinery

EXCAVATING EQUIPMENT

SHOVELS AND DRAGLINE SCRAPERS:

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Gears, Chains and Wire Rope	**TEXACO CRATER COMPOUND NO. 1 OR NO. 2, ACCORDING TO WEATHER CONDITIONS, TEMPERATURES AND PRESSURES INVOLVED**

(Continued on Inside Back Cover)

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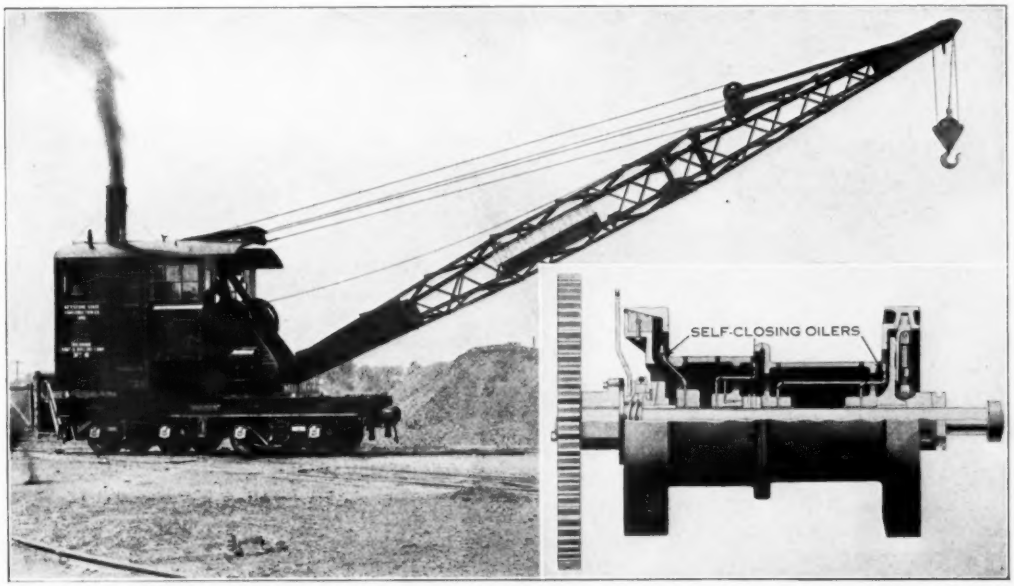


Courtesy of Industrial Works.

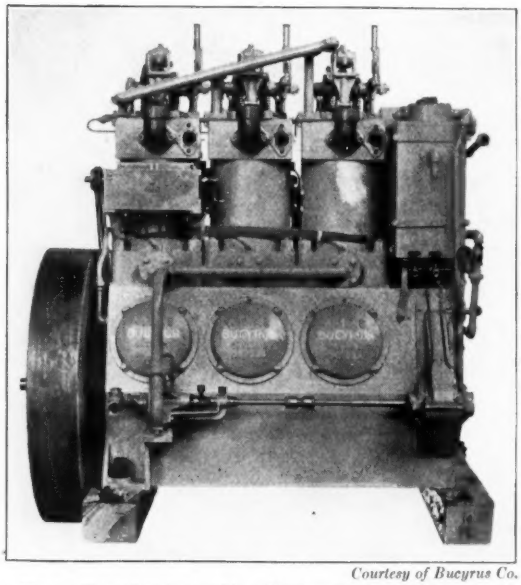
Fig. 1—A typical locomotive crane. Insert shows the details of the independent automatic drums. Note the self-closing oilers which are never concealed by rope.

Lubrication of Rock Products Machinery

THE rock products industry is distinctive for the magnitude of its output, the size and capacity of the machinery involved, and the extensive field which it covers. To appreciate its importance in the furtherance of industrial progress an encyclopædia of the uses to which the respective products can be put would be necessary. Some twenty-seven different substances are involved; chief among these are crushed stone, granite, shale, limestone, sand, gravel, phosphates, feldspar, sandstone, marble and slate.

For the purpose of this article, however, but a brief mention of these products is warranted. Essentially, we are concerned with the operation and lubrication of the machinery involved.

The total power required for the operation of this equipment is above 2,000,000* horse-power. It comprises steam, electricity and the internal combustion engine; the first two predominating to a large extent. To serve these prime movers and the other miscellaneous equipment in-



Courtesy of Bucyrus Co.

Fig. 2.—Type of engine used in a Diesel engined excavating and rock handling machine.

volved, such as crushers, steam shovels, excavators, screens, skips, washers, etc., approximately 12,230,000 gallons of oil, and 12,120,000 pounds of grease are required per year, at a probable cost of about $6,100,000.00. On a unit basis, this would amount to approximately 6.0 gallons of oil and 6.0 pounds of grease per horse-power, at a total estimated cost of $3.00 per horse-power per year.

From a comparative point of view, these figures are of vital interest to the management of rock products plants. Too, they are complimentary to the industry as a whole, when we take into consideration the inherent difficulties which accompany the attainment of effective lubrication. It is a heart-breaking task to attempt to lubricate a steam shovel, screen, crusher or conveyor. Weather conditions, dust, abrasive matter, moisture and oftentimes chemical fumes tend to counteract the friction-reducing ability of practically any lubricant; and it is almost an impossibility to operate under any other but these conditions.

RECOVERY OF ROCK PRODUCTS

Excavating Equipment

The essential equipment in practically every phase of rock products recovery from quarry or pit is the power shovel of either the steam, electric, gasoline or oil engine type. The former predominates today, although both electric and internal combustion engine power for shovel operation are being received with more and more favor.

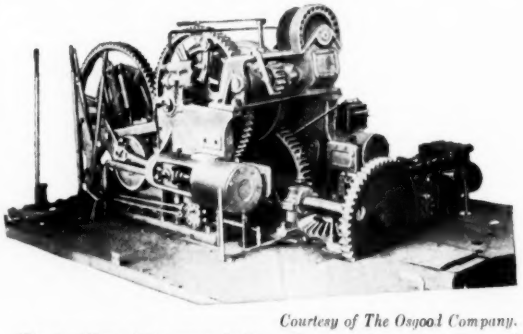
The scooping and handling of blasted rock, stone, shale, etc., from the quarry, and the digging or scooping of gravel and sand from beds or pits is the first step in the recovery of rock products wherein handling machinery is used. In the quarry the power shovel is most generally employed. In the sand or gravel pit, however, both the shovel and dragline excavator may be used according to the area to be worked.

The Power Shovel

The power shovel works over a relatively limited area, handling its material by means of a dipper, shovel or grab bucket.

Power shovels are usually built along two designs according to the class of service they are to be used for, and are customarily known as the revolving and railroad types. The principles of operation of both are similar, although the former is intended for lighter work. The latter is very adaptable to stone quarry service.

In general design, a power shovel consists of a revolving frame or turntable which carries the boom or shovel arm, the engines and other operating mechanisms. A suitable carrying frame or truck which may be equipped with standard railroad wheels or mounted on a truck, fitted with broad traction wheels of the trackless type, or a caterpillar tractor device may also be installed. In practically every case the machine is self-propelled. The revolving frame is carried on roller bearings or cone



Courtesy of The Osgood Company.

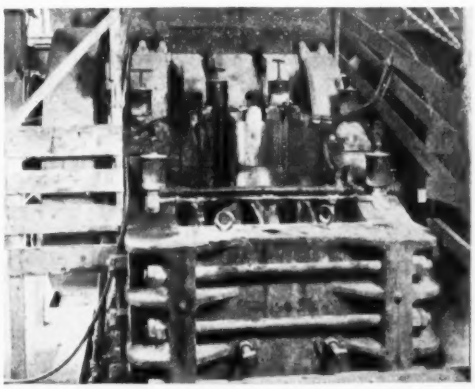
Fig. 3.—View of the upper body machinery and auxiliary drum, of an excavating machine as used in clamshell and dragline work.

rollers, which travel on a suitable swinging gear casting, securely attached to the truck frame.

Hoisting engines in use on many types of power shovels are of the steam driven, ver-

*Statistics by courtesy of ROCK PRODUCTS.

tical or horizontal type, receiving their steam from a locomotive type or upright boiler located on the turntable. Both engines and boiler are free to swing with the turntable, as has been mentioned above, being mounted on rigid bases and securely bolted to the main revolving casting, so that vibration becomes relatively negligible.



Courtesy of C. G. Buchanan Co., Inc.

Fig. 4.—End view of a rock crusher of the jaw type, showing grease cups and leads for lubrication of the essential bearings.

Gasoline, kerosene and electric power driven engines may be used to supplement the steam boiler and steam engines if desired on certain types of shovels. There are in general three engines required for the efficient operation of a power shovel, i.e., a hoisting engine which controls the rise and fall of the shovel or dipper; a swing engine for the revolving of the turntable; and a thrusting engine to operate the shovel in the process of digging.

The Dragline Excavator

The dragline excavator, on the other hand, is adapted to a wider area. It operates by means of a boom and scraper bucket, the latter being dragged through the material to be handled during this process. It is especially adaptable to sand and gravel pits where skimming, scraping or stripping is chiefly to be done, and where the materials respond comparatively readily to the action of the bucket or scoop. In construction, such a machine is much similar to the power shovel, with the power plant, boom and controlling mechanism mounted on a revolving turntable. The boom is usually longer, however, than the shovel boom and carries a ditcher or scraper bucket adequately controlled by draglines or cables. In operation the bucket is raised to the required height by the hoisting engine, swung over the area to be excavated, and dropped or thrown (according to the skill of the operator) to the desired location. Then by taking up on the dragline the bucket is filled by dragging through the material, after which it is raised and swung to the point of disposal.

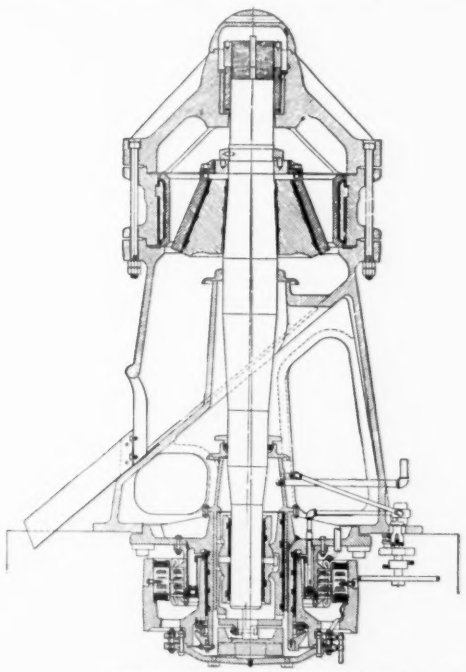
According to the nature and ultimate use which is to be made of the product, it is then either conveyed to the crushing mill for further refinement, or, if it is to be used in the raw state, it may be loaded directly to the shipping cars. The intermediate conveyors which operate between the quarry or pit and the mill, in general comprise industrial rail cars, motor trucks, or tractor-drawn carriers.

REFINING EQUIPMENT

The treatment of rock products from this point on can well be termed a process of refinement. Dependent upon their nature, and the purpose which they are to serve, crushers, pulverizers, screens, conveyors and washers, etc., may be involved.

Crushers and Breakers

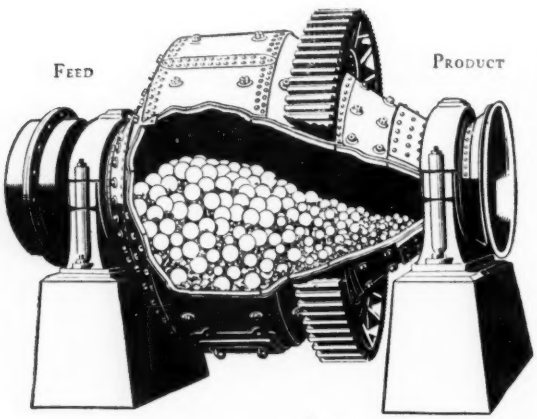
The first treatment which rock or stone receives is a certain amount of crushing or breaking dependent on the ultimate product desired. As a rule this process may be subdivided into two classifications, i.e., (1) preliminary and (2) finishing. Preliminary crushing constitutes the breaking up of the product into a sufficient state of fineness to render it suitable for final grinding or pulverization. For this purpose, jaw crushers, gyratories or single-roll crushers are used.



Courtesy of Kennedy Van Saun Mfg. and Eng. Corp.

Fig. 5.—A ball bearing gearless gyratory crusher showing general arrangement of parts, and details of continuous oiling system.

Jaw crushers in general are particularly adaptable for the primary breaking of products such as trap rock and granite. To a certain extent they have less capacity for their weight than gyratory crushers. Roll crushers are extensively used for primary breaking of limestone.



Courtesy of Hardinge Company.

Fig. 6.—A conical drum ball mill. Note varying size of balls. Such a mill classifies as well as crushes the material.

Gyratories are especially adapted to cement mill work for the reduction of rock to the proper size for pulverization. A word in regard to the construction of a gyratory will be of interest. Essentially, it involves a vertical conelike shell, within which is located a conical crushing head mounted on a suitable shaft. This latter is suspended from the top of the casing which is the point of least gyration, being held by a spider and suspension ring or bushing. At the bottom, this shaft is provided for circular rolling motion by virtue of a suitable eccentric mechanism. As a result during rotation, the breaking surface of the crushing head approaches successively every point of the interior of the concaves or throat. This action results in a continuous breaking of the material, which then falls through at that point of the throat from which the head is most distant, being discharged by a suitable hopper below.

At the bottom of the shaft, provision is made for lubrication of the driving eccentric mechanism. This can be admirably brought about by providing for bath or pressure lubrication from a reservoir of oil located below the bottom of the shaft.

Rock as it is received from the crusher or breaker may require more or less further refining, according to the purpose for which it is to be used. For highway construction and building purposes, the product of the gyratory may be ready for usage.

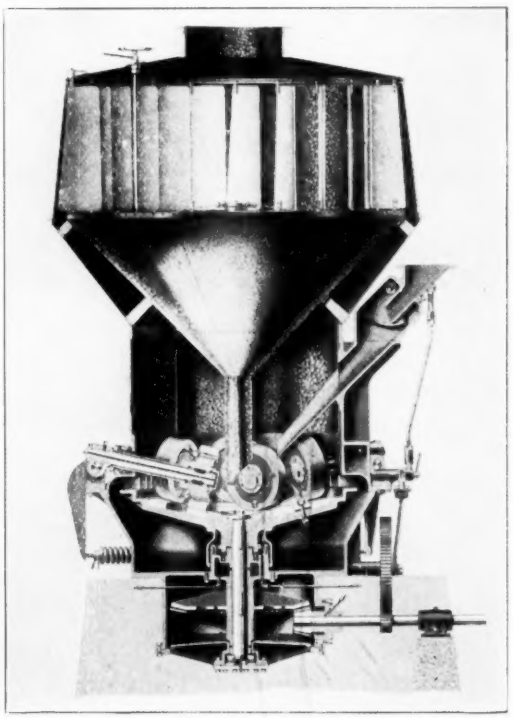
Hammer Mills

In the cement plant, on the other hand, it may have to be put through a hammer mill if it is too large for drying or pulverizing. The hammer mill consists of a number of steel hammers which revolve around a horizontal shaft at high speed, striking the fragments of rock as received via the charging hopper, to hurl them with great force against the breaking blocks in the case. The force of this impact serves to break up or shatter the rock to the requisite extent.

Pulverizers

Pulverizers usually involve an arrangement of rolls or some form of ball or tube mill, for the purpose of finishing broken stone, gravel or whatever the product may be to the requisite fineness.

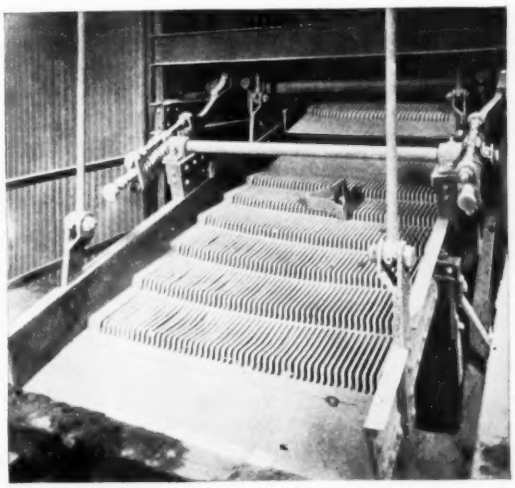
Roll finishing is applicable to a wide variety of materials, though the details of machine construction will depend to a certain extent upon the degree of hardness of the product, or its content of silica. A hammer crusher equipped with rolls, for example, can be used for the reduction of shale, slate, limestone, etc., to a state of fineness suitable for ball or tube mill treatment. The breaker roll in turn is



Courtesy of Bethlehem Shipbuilding Corp., Ltd.

Fig. 7.—Detailed view of a pulverizer as used for fine reduction purposes. Roll members are force grease lubricated through the ends of the shafts. The driving gear mechanism is oil lubricated.

suited to the crushing of coal, phosphate, rock and other comparatively soft material, the rolls being corrugated or equipped with pointed teeth for the purpose of both crushing and tearing the smaller particles. Then, again, the rolls may be tapered as is customary in the



Courtesy of The C. O. Bartlett & Snow Co.

Fig. 8.—A typical shaking screen. Note grease lubricated vibratory mechanism.

clay-working industry, performing the dual purpose of crushing and removing foreign matter such as large stones, etc., at the same time.

For very fine reduction of rock products, however, the ball, tube, rod, or ring type of mill is generally used. In the cement industry, for example, these machines are extensively employed where uniform fineness of relatively hard material is necessary, with the elimination of dust as far as possible, and a high rate of continuous production.

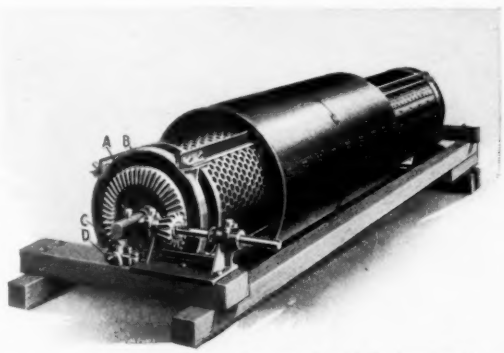
A ball mill is essentially a revolving steel drum partially filled with steel balls, which continually roll to the bottom of the drum, grinding the particles of rock between and beneath them. In principle the ball tube, rod and tube mills are much similar to the ball mill. They are usually larger, however, and capable of finer grinding. The tube mill, in turn, serves also as an effective mixing device. Essentially a tube mill is a long revolving steel cylinder fitted with a suitable protective lining to prevent wear on the shell. Both ends are closed, the interior being filled with flint pebbles or pieces of quartz. As the cylinder revolves these abrasive particles, together with the product to be ground, continually tumble down over one another. The resultant contact serves to reduce the material very successfully.

Rod mills in turn are much like tube mills, with the exception that the grinding media consists of steel rods instead of flint or quartz, etc. These rods lie parallel in the cylinder; in general they tend to work primarily on oversize product. Uniform and economical grinding is claimed for the rod mill; furthermore the steel rods employed are in general less costly than forged steel balls, etc.

Screens

Following the process of crushing and pulverization, whatever the product involved, it must usually be subjected to a certain amount of screening to segregate the particles according to their size and fineness. In certain phases of the industry this process is relatively rough, as, for example, in the preparation of crushed stone for highway and building purposes. In the cement mill, on the other hand, it is absolutely essential to screen out all coarser particles of stone for the fines must run uniform in size.

For the purpose of screening both rotary devices and vibrating screens are used. The former are extensively employed in stone quarry service; they consist essentially of one or more cylinders or barrels composed of perforated plates so located as to afford continuous travel of the product under treatment. The ends, of course, are closed. Screens of this type are supported by suitable bearings or rollers at each end. Rotation is brought about at the driven end by means of gears, usually of the beveled type, the pinion or driver being keyed to a shaft, which is in turn actu-



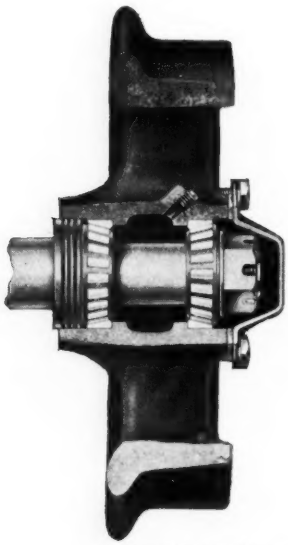
Courtesy of Smith Engineering Works.

Fig. 9.—A heavy duty rotary screen. Note bevel driving gear arrangement "A;" the end casting "B;" the end thrust bearing "C;" and adjusting screw "D."

ated by an electric motor, chain or belt connection.

Screens of the vibrating type are extensively used for the separation and classification of finer materials. These devices bring about the desired result by reciprocating or vibrating action of the frame of the screen fabric with

respect to the crushed product, in much the same manner as one would sift ashes by a hand screen. Vibration is usually set up by means of an eccentric mechanism driven by motor, chain or belt power. Screens of this type are



Courtesy of The Timken Roller Bearing Co.

Fig. 10.—A quarry car wheel equipped with roller bearings. This is an especially advantageous installation for insuring positive operation with economical lubrication.

generally set on more or less of an angle, the product being screened wet or dry according to the process involved. In the clay working industry wet screening, for example, is extensively used.

LUBRICATION

Excavating Machinery

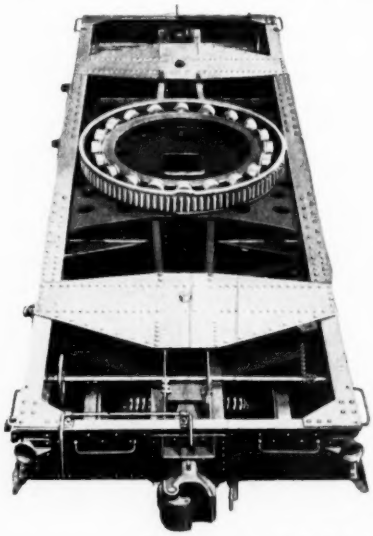
Steam Cylinders

In order to keep power shovels, scrapers, and other excavating machines in continuous operation, it is decidedly essential to give every care to their lubrication at all times.

In the steam-driven machine, perhaps the most important detail is the lubrication of the steam cylinders. In the operation of practically any type of excavating machine, which may be steam driven, the existing conditions will be such that if any but a high grade, properly compounded lubricant is used, the cylinders will suffer accordingly.

As a general rule, the steam used on these machines will be of comparatively low pressure (ranging from 100 to 160 pounds). As a result it may have quite an extensive moisture content. For although it is usually taken from the highest part of the boiler, it will frequently be relatively wet when it enters the header. Furthermore, line condensation between the boiler and engine will be high, with a corresponding decrease in pressure due to the fact that the steam pipes are often not covered to any great extent and the engines are frequently subject to intermittent operation. As a result there will almost always be an accumulation of water above the throttle valve prior to starting the engine, depending in amount upon the length of time it has been stopped. Now, if the cylinders are not covered with a tenacious film of properly compounded lubricant, the admission of these slugs of water will tend to wash the lubricant from the wearing surfaces, and for the next few strokes insufficient lubrication will be possible and scoring and abnormal wear may occur. The constant repetition of the above will not take long to induce frictional losses, and inefficient operation of the entire machine due to steam leakage past the piston rings. Groaning of the engine or chattering of the valves on their seats may also occur under extreme conditions.

As a result the problem is to select and use a grade of steam cylinder oil which contains a sufficient amount of high grade animal or fixed oil to promote the formation of an extremely adhesive film of emulsified lubricant, which will adequately resist the washing action of any water that may be present. To insure the best results, the base of this lubricant should be

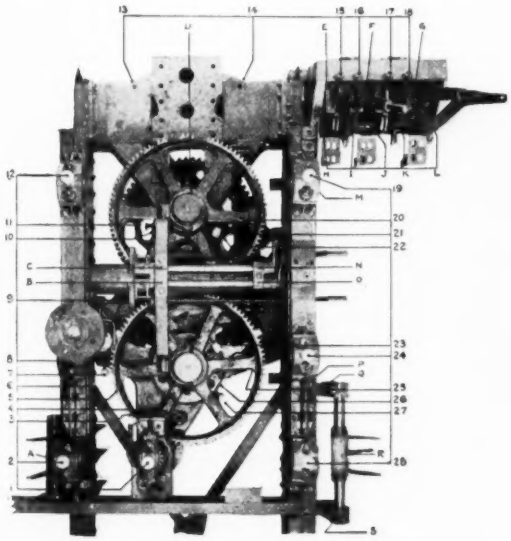


Courtesy of American Hoist & Derrick Co.

Fig. 11.—Top view of a locomotive ditcher car body showing center casting bull gear and conical steel rollers on which the deck revolves.

a medium viscosity, highly adhesive, steam cylinder stock. For this purpose a comparatively high compound cylinder oil ranging in the neighborhood of 130 seconds Saybolt viscosity at 210 degrees F. will in general meet the variable requirements involved.

It is not enough, however, to choose the proper grade of oil. The means of application is also of importance. In order to efficiently lubricate engines under such conditions, the oil should be delivered by a positive feed lubricator, via suitable atomizers. It is possible to



Courtesy of Harnischfeger Sales Corp.

Fig. 12.—Lubrication chart for the revolving frame and inner parts of an excavating machine. Numerals denote greasing points; letters signify where oil should be used.

use either hydrostatic lubricators or mechanical devices for this purpose.

The location of the oil pipes and atomizers in the steam lines is also important. These points should be approximately from 4 to 6 feet back from the throttle valves. In cases where a steam thrusting engine is located on the boom in certain types of these machines, the oil line often enters the steam pipe much further away from the throttle, with the result that in event of a steam leak at the ball or swing joint there will be considerable loss of oil as well, with in all probability insufficient lubrication just as long as this leakage is allowed to continue.

General Lubrication Including Motor Bearings

In the average excavating machine which is used for the recovery of rock products from the earth, general lubrication may be regarded as covering the external wearing parts of engines, bearings and in fact all else but gears, chains and wire rope, which will be discussed independently.

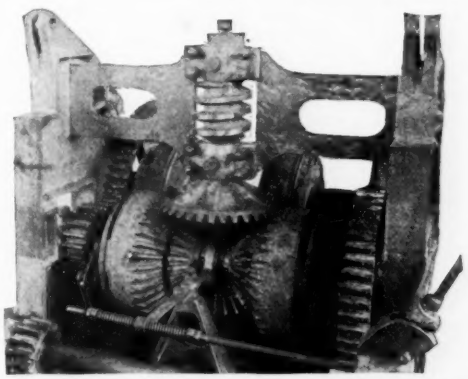
On excavating machines which are equipped with caterpillar tractors the lubrication of link-pins and rollers is often an important item. The object, of course, is to insure against excessive friction losses, and power consumption. Automatic lubrication is generally regarded as most satisfactory, the lubricant being furnished from internal reservoirs located in the treads and rollers. For this service the engine oil mentioned below, will in general meet the requirements.

On certain types of shovels and other excavating machinery, journal boxes akin to those used in railway service may be installed on traction wheel journals. As a result the latter, although they are not subjected to the same high speeds and lengthy periods of operation as are prevalent in the railroad service, are lubricated in a similar manner by packing the journal box with wool waste which has been saturated with mineral oil.

As a rule other wearing parts on the average excavating machine can be taken care of by means of a medium viscosity straight mineral oil ranging from 300 to 500 seconds Saybolt viscosity at 100 degrees F. or by a high grade of cup grease. Many builders equip their machines for grease lubrication. The product used for this purpose should be free from acid or alkali and should contain no filler such as talc or asbestos which would tend to clog the oil-ways.

In order to insure more positive lubrication of parts such as the block on the lower tension cable on certain types of excavators, the builders have installed ball bearings. As a result, the necessity of the operator climbing up to re-lubricate at periodic intervals is eliminated and the operation of the bucket has been found to be improved.

Engine bearings, and other parts which are to be lubricated with oil, can generally be oper-



Courtesy of The Byers Machine Co.

Fig. 13.—Boom raising and lowering mechanism on a full circle crane. Frequent moving is eliminated by this device. Careful and adequate lubrication is of course an essential.

ated on a 300 to 500 seconds viscosity straight mineral lubricant as has already been stated. For motor bearings, however, as are involved in electric driven machines, a lighter oil will in all probability give better results; as a rule

ring oiling systems are installed on these motors. This oil should range from 180 to 200 seconds viscosity.

In addition, there are many parts on every excavating machine which will frequently require hand oiling. This is not recommended,

Courtesy of Traylor Eng. & Mfg. Co.

Fig. 14.—The toggle mechanism and swing jaw of a bulldog jaw crusher. This particular type is distinctive and advantageous, in that no lubrication is required for the toggle seats, inasmuch as rolling action alone is involved.

however, due to the possibility of oil holes becoming clogged with dust and dirt and the bearings suffering accordingly. It has been proven that sight feed oil cups will give very much better results. They should at all times be covered, however, so that the contents will be kept free from entry of contaminating foreign matter.

Internal Combustion Engines

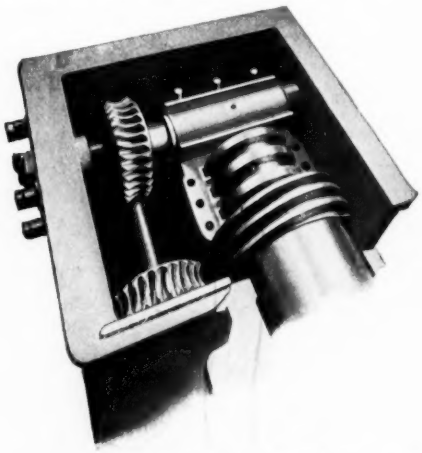
Where power shovels and scrapers are operated by oil, kerosene, or gasoline engines instead of steam or electric power, lubrication develops into a problem akin to that involved in the modern automobile, tractor or oil engine. In part this has been discussed in recent issues of "LUBRICATION"* both from a practical and technical point of view.

For such service the engine oil is of chief importance and it should be given careful consideration, taking into account the operating conditions involved and the requirements imposed on the oil, which have been so extensively discussed in these past issues of "LUBRICATION". As a rule some form of circulating lubricating system will be involved, the oil passing either through a hollow crank shaft under adequate pressure to reach all the wearing parts or being splashed by the connecting rods, etc. On oil and gasoline engines a straight mineral engine oil from 300 to 750 seconds Saybolt viscosity at 100 degrees F. will be applicable, the grade selected being dependent upon the weather and operating temperatures. For tractor type engines a somewhat heavier lubricant should be used.

*See "Lubrication" for Jan. 1923; Sept. 1923; Feb. 1924; Dec. 1924; April 1925 and July 1925.

Gears, Chains and Wire Rope

Other wearing parts which also will in all probability present lubricating problems on the average excavating machine are the gears, chains and wire rope. In order to insure the preservation of this equipment, and maintain operation at the highest state of efficiency, it is essential at all times to keep these parts well coated with a suitable compound which will serve not only as a lubricant but also as a preservative. Wire rope in particular requires attention due to the possible hazard involved if internal strands are allowed to rust, wear and corrode. Although wire rope as constructed today contains a hempen core which is usually soaked in lubricant prior to the winding of the steel strands, the theory that this core will serve to adequately lubricate the strands and prevent wear, rust and corrosion during subsequent operation should not be relied upon. Therefore, the external surface of the rope should be treated at frequent intervals with a suitable lubricant and preservative which is capable of penetrating to the innermost strands during operation, not only re-lubricating the core but as well preventing wear at the points of contact of the strands.



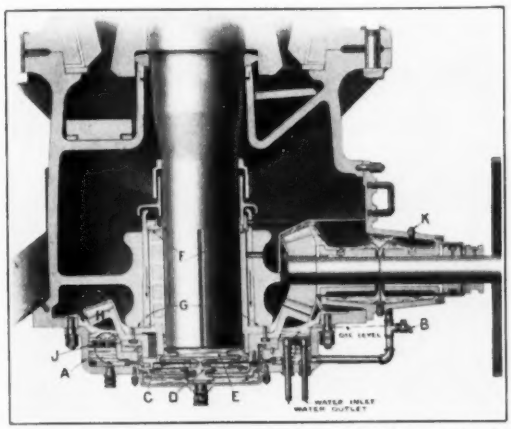
Courtesy of Traylor Eng. & Mfg. Co.

Fig. 15.—The "fleeting roll" mechanism of a heavy duty crushing roll device. Grease lubrication is recommended for this mechanism.

In order for a lubricant to adequately meet these conditions it must be—

1. Capable of being readily applied in a thin uniform film without undue heating.
2. Free from acid and alkali.
3. Plastic at all temperatures.
4. Non-evaporating.
5. Non-hardening.

6. Insoluble and resistant to water.
7. Capable of resisting the entry of dust, dirt and other foreign matter.
8. Adhesive and tenacious enough to insure that it will not run off or drip under abnormal pressures or temperatures



Courtesy of Allis-Chalmers Mfg. Co.

Fig. 16.—Oiling system of a gyratory crusher. "A" is the bottom plate, and oil reservoir; "C" the centrifugal pump; "D" the diffuser. From the latter oil passes to space "E" inside the eccentric below the shaft. Thence it is forced up between eccentric and shaft overflowing the top through holes "F." In returning it flows by gravity through clearance space "G," between the main bearing and eccentric flange. Centrifugal force throws ample oil over the gears to give adequate lubrication. "J" indicates the cooling coils.

The most generally suitable lubricant to meet these conditions is a pure petroleum product having a viscosity of from 1000 to 2000 seconds Saybolt at 210 degrees F. This lubricant is also applicable to gears and chains on the average rock products excavating machine.

Whatever the type of machine involved, the setting and aligning of gears is important, and all these should so mesh that there will be a uniform and constant application of power, with smooth, quiet operation in order to insure against jerky action of the parts which they operate. The occurrence of this latter would tend to produce strains and abnormal wear, not only on the gears, but also on other driving mechanisms. To attain the best results in applying the gear lubricant the surfaces of all teeth should first be washed with kerosene or some other solvent, the lubricant then being heated and brushed or poured lightly onto the wearing surfaces while the gears are in slow rotation. Pressure between the teeth will adequately spread the lubricant if it is applied in the proper amount, and it should not be forced over the sides of the gears unless the film is too thick. In this event the intensity of the application should be decreased.

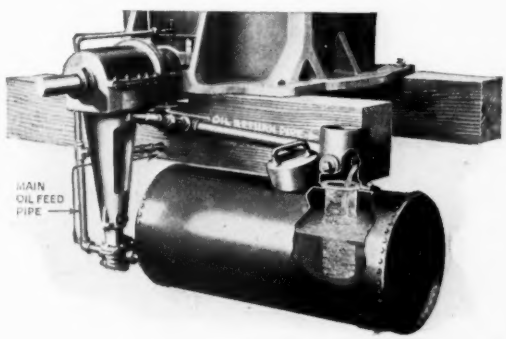
Refining Equipment

Jaw Crushers and Breakers

Lubrication of such equipment is essentially confined to the bearings of the pitman and eccentric shaft. The former carry the pitman or heavy steel casting which oscillates with its bearing as the point of suspension, to bring about the requisite degree of crushing. As a rule the pitman bearing is water cooled; in addition, in certain larger crushers it is relieved of much of the weight by the use of links and coiled springs, for the potential friction involved is considerable.

As a result, lubrication of the pitman bearing is of decided importance. Grease is usually the most generally adaptable lubricant, being applied to the bearing either by means of pressure lubricators or via reservoirs equipped with wool waste or some other form of pad retainer to insure positive lubrication without undue loss. Where pressure lubrication is employed a compression cup grease will usually be most adaptable. The use of wool waste or pad lubrication, however, will require a thinner grease, relatively fluid in consistency, in order to enable proper penetration of the wool. In both instances the lubricant must be capable of reaching the lower wearing surfaces where pressures and friction will be the greatest. To more safely insure this certain builders provide for delivery of grease (under pressure) to both the top and bottom of the bearings.

Eccentric bearings likewise require positive lubrication with a suitable grade of grease. Unless the weight of the pitman is more or less balanced by springs, etc., its weight will be exerted upon the eccentric shaft bearings, with

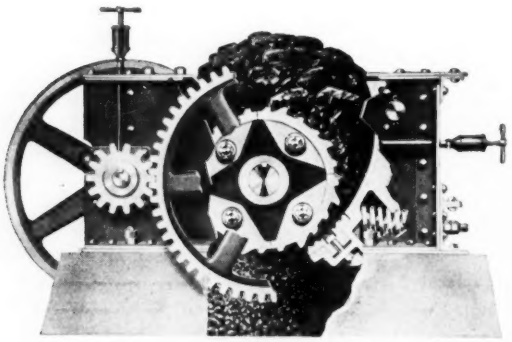


Courtesy of Smith Engineering Works.

Fig. 17.—A gear type oil pump as installed on the Telsmith primary breaker or gyratory. Note the oil lines, strainer and sight feed.

the probable result that the lubricant will be unable to penetrate and maintain the requisite friction-reducing film between the shaft and bearings. The construction of the crusher must therefore always be taken into consideration; where springs and links are used to

balance the pitman, reservoir pad lubrication using liquid grease will probably work out satisfactorily. Where the weight of the pitman is exerted on the eccentric bearings, as well as on its own supports, pressure lubrication with a heavier grease will be more positive.



Courtesy of Pennsylvania Crusher Co.

Fig. 18.—A rotary crusher. Note segmental roll construction and pressure lubricating devices for grease application.

Toggle seats may or may not require lubrication, all according to the nature of their construction. Where rolling motion is provided for, it is claimed that the need for lubrication is eliminated. Certain types, however, will involve sliding friction at the toggle seats. In such cases oil lubrication is usually provided for by the builders by means of suitable drip cups. For this purpose a relatively heavy machine oil will serve the purpose.

Gyratory Crushers

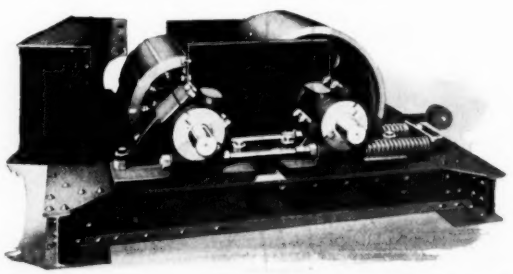
In the modern gyratory the matter of eccentric, gear, counter shaft and ball bearing (where installed) lubrication is a most important proposition. Automatic lubrication whereby the oil is circulated under pressure throughout these lower mechanisms is becoming practically standard on all such equipment due to the absolute necessity for continued and dependable maintenance of a sufficient flow of oil to not only withstand the pressures involved but also to remove any excess of heat developed.

This is brought about by means of a suitable oil pump which is located at the bottom of the crusher either within or adjacent to the oil reservoir or chamber in the bottom plate. An ample supply of oil is contained in the system, which as a rule includes a suitable filter or strainer through which the oil passes at each circulation. This, together with the general dust-proof construction of the modern gyratory insures against the entry and circulation of an excess of dust through the system. As a result all the lower wearing parts are served with a flood of clean, cool oil throughout the period of operation of the gyratory crusher, for by virtue of the nature of the design and construction the oil pump starts simultaneously with the latter, operating at a speed commensurate with the rate of crushing.

Under normal conditions of crushing, provided the system has an ample oil capacity, overheating will not usually present any difficulty. Where hard rock is to be crushed, however, during very hot weather, or in event of using too viscous an oil, it will be found advantageous to provide for cooling the oil during its circulation. The builders enable this on certain crushers by installing a water cooling coil in the oil chamber itself. Not only does this enable the cooling of used oil, but also it renders cold weather starting more feasible for steam or hot water can likewise be circulated through such coils to warm up the oil.

For general warm weather lubrication of such equipment in systems as illustrated and discussed above, a straight mineral crusher oil of approximately 140 seconds Saybolt viscosity at 210 degrees F. will usually give the best results. In cold weather, however, it will always be advisable to resort to an oil of lower viscosity especially if there is no provision (in the form of cooling or heating coils) in the system for heating the oil prior to starting or during operation. Usually a viscosity of from 500 to 750 seconds Saybolt at 100 degrees F. will be best where a lighter oil is required, according to the necessity for lower pour test and greater fluidity especially on starting.

The top bearings, suspension and wearing rings within the dust or spider cap at the top of the main shaft of the average gyratory crusher will also require considerable care in lubrication. Essentially a product must be chosen which will not run prematurely through the bearings, to perhaps leave their surfaces

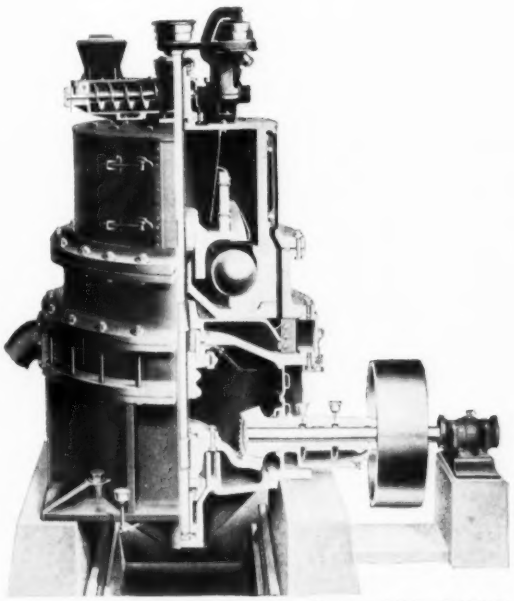


Courtesy of The C. O. Bartlett & Snow Co.

Fig. 19.—A set of crushing and disintegrating rolls. Note reservoirs for lubrication of the roll shaft bearings.

susceptible to excessive friction and wear. As a general rule crusher oil will be best for this purpose, or perhaps a somewhat heavier straight mineral lubricant of approximately 200 seconds Saybolt viscosity at 210 degrees F. To facilitate the retention of the oil, the space

within the cap can be packed with a pad of wool waste saturated in the lubricant. This should last for several weeks, provided that a small quantity of fresh oil is added every day or two via the oil hole in the cap.



Courtesy of Fuller-Lehigh Co.

Fig. 20.—Details of a gear driven pulverizer mill. Note the rigid construction and the fact that there are no inside journals or bearings requiring lubrication.

Ball, Tube and Rod Mills, etc.

Pulverizers of this character, especially those which are carried upon horizontal shafts, are difficult to lubricate, because of the great weight carried by the shafts and the fine dust which will always find its way into the bearings. Every possible precaution is taken to keep this dust out of the bearings, but it is practically impossible to attain this ideal, with the result that foreign matter of this nature is frequently the cause of their rapid destruction. The main shaft bearings are relatively large so that the unit loads are not excessive, but in spite of this it is necessary to use a lubricant possessing considerable body in order to prevent undue frictional heat. Fortunately, such mills revolve comparatively slowly and there is no objection to a heavy lubricant from the viewpoint of speed. As a rule cup grease of medium consistency will be the most suitable lubricant for these bearings.

Bearings may run hot because an unsuitable lubricant is used, because they receive insufficient or perhaps no lubrication, or because of some mechanical defect such as poor alignment of the shaft, insufficient clearance, etc. In any event, in the operation of any mill, as soon as heating is evident, the machine should be stopped wherever possible. The most efficacious way of reducing heat is to loosen up the bearing and then flood it with oil. At the first opportunity, of course, the bearing itself should be examined to see that the grooves and oil ways are not clogged; all other mechanical faults should also be corrected.

Because of the speed at which it revolves, the pinion shaft on such mills is frequently carried in ring-oiled bearings. The most suitable lubricant for these is an engine or machine oil of about 200 seconds Saybolt viscosity at 100 degrees F.

For the gears of such mills the most satisfactory lubricant will usually be one with adequate body or viscosity to prevent metallic contact under heavy loads and resist the drying action of dust. As a rule a straight mineral lubricant of approximately 1000 seconds Saybolt viscosity at 210 degrees F. will best serve this purpose.

Crushing Rolls

Lubrication of these devices is essentially a simple matter. Bearings of roll and gear shafts, and the gears themselves are the usual wearing parts requiring such protection. As a rule grease will best serve the purpose, a medium grade of compression cup lubricant being adaptable to the average pressure lubricator used for its application.

Courtesy of Sturtevant Mill Co.

Fig. 21.—The power plant and vibrating unit of a moto-vibro screen. The entire frame in such a machine is vibrated. Note provisions for grease lubrication.

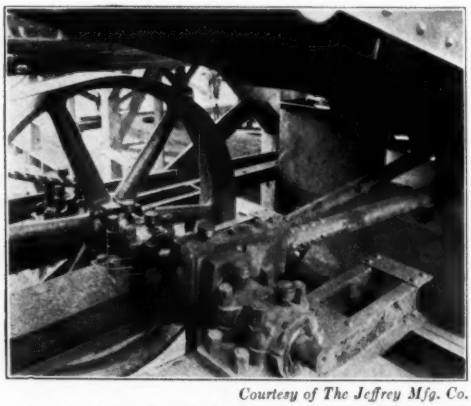
Gearing, in turn, by virtue of its usual exposed nature will function best if treated at periodic intervals with a fairly heavy-bodied gear lubricant. Care must be taken that this is not applied in excess, however, or that too heavy a product is not used, otherwise there

will be a tendency of dust accumulating, the resultant paste or scale of dust-impregnated lubricant being thrown off during subsequent operation.

Lubrication of Screens

Rotary Type

As mentioned before, screens of this type are usually carried on two points of support—one at each end. The mechanism at the driving end of course involves the most difficulty from



Courtesy of The Jeffrey Mfg. Co.

Fig. 22.—Drive of a shaking screen. Note that provision is made for grease lubrication.

a lubricating point of view, especially in regard to the gears. These latter will, as a rule, operate exposed with their lubricants subjected to contamination by dust, dirt, and probably moisture. Also in many cases they may be exposed to wide variations in temperature which would likewise tend to reduce the efficiency of lubrication.

These conditions would, of course, also affect the bearings to a certain extent, although the housings, if properly designed and installed, would prevent at least the entry of an excessive amount of dust and dirt. As a rule these are plain babbitted bearings with provision for grease lubrication. Under the prevalent operating conditions grease is probably a better lubricant than oil due to its ability to maintain a more effective seal against entry of abrasive foreign matter. It must be a product insoluble in water, however, due to the possibility of its having to withstand the washing action of rain, or any water used during screening. As a rule a cup grease of medium body or consistency will be best suited to these conditions, and capable of ready application by means of some form of compression cup or other pressure lubricator.

For the gears (including girth gears wherever installed) a lubricant must be used which will not only form a protective film to counteract the abrasive effect of dust, dirt, etc., but will function irrespective of temperature, moisture, or weather conditions. This is a broad requirement, one in fact that very few compounded lubricants or greases will meet with any degree of success. Experience has proven that a straight mineral residual product, of fairly inert characteristics, will give the most satisfactory results. Usually a viscosity of approximately 200 seconds Saybolt at 210 degrees F. will adequately serve the purpose. On the other hand, high temperatures might require a higher viscosity of say 1000 to 2000 seconds Saybolt. Heavier lubricants, however, will tend to agglomerate dust, to ultimately ball up and scale or be thrown off, leaving the teeth practically exposed.

An advantage possessed by heavier lubricants, however, is their highly adhesive characteristics and their capability of resisting the effects of centrifugal force under higher speed conditions provided they are sparsely applied.

Of course, where it is possible to enclose such gears the practice is very advisable. Not only will a housing serve to reduce the extent of entry of foreign matter, thereby promoting better lubrication, but also it will serve as a means of protection for the operator.

Vibrating Screens

In the case of vibrating screens the vibratory mechanism is somewhat more intricate than the driving gears and bearings of a rotary screen. It may, therefore, develop more potential difficulties in regard to lubrication. Grease lubrication has been found to be very satisfactory on such equipment, affording the requisite protection to the various bearings by preventing the entry of dust and dirt. As a rule some form of compression or pressure grease lubricating device should be used to insure as nearly positive lubrication as possible. In such equipment a medium bodied compression cup grease will be suitable.

CONCLUSION

In brief, the lubrication of Rock Products machinery becomes a matter of—

1. Using clean, properly refined lubricants.
2. Designing wearing surfaces and lubricators as nearly oil-tight and dust-proof as possible.
3. Changing lubricants at frequent intervals and—
4. Maintaining all parts to be lubricated, as clean and free from foreign matter as is consistent with operating conditions.

Rough conditions should not be accepted as inevitable. Nor should the matter of lubrication and lubricants be regarded in too casual a manner. It is the best and most decided means of keeping machinery operating and increasing production.

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